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B Decays with J/psi or Baryons from Belle

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We report the results of a study of B-meson decays with J/ψ or baryons in the final state. It includes observation of $B^- \to J/\psi\Lambda\bar{p}$, $B^{+/0} \to \Lambda_c^+\bar{\Lambda}_c^- K^{+/0}$ and $B^+ \to \bar{\Xi}_c^0\Lambda_c^+$ decays and search for $B^- \to J/\psi\Sigma^0\bar{p}$, $B^- \to J/\psi p\bar{p}$, $B^0 \to J/\psi\bar{D}^0$, $B^0 \to J/\psi\bar{D}^0\pi^+$ and $B^0 \to \bar{\Xi}_c^-\Lambda_c^+$ decays. These results are based on the analysis of data collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy e^+e^- collider.

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1. Introduction

Recently, the Belle Collaboration observed a number of baryonic B decays, charmless [1] and charmful [2]. Belle continues a study of such decays and reports the results on the new modes.

To isolate the B-meson signal For all reported decays, to isolate the B-meson signal we use $\Delta E = \Sigma_i - E_{\rm beam}$ (or $\Delta M = M(B)_{\rm inv.} - M(B)_{\rm table}$) and beam-energy constrained mass $M_{\rm bc} = \sqrt{E^2_{\rm beam} - (\Sigma_i \vec{p}_i)^2}$. Here $E_{\rm beam} = \sqrt{s}/2$ is the beam energy in the center of mass, $\vec{p}_i$ and E_i are the three-momenta and energies of the B candidate's decay products, $M(B)_{\rm inv.}$ and $M(B)_{\rm table}$ are the reconstructed B-meson mass and the world average B-meson mass.

2. Observation of $B^- \to J/\psi\Lambda\bar{p}$ and Searches for $B^- \to J/\psi\Sigma^0\bar{p}$ and $B^0 \to J/\psi p\bar{p}$

We present the observation of the decay mode $B^- \to J/\psi\Lambda\bar{p}$, which is a new type of baryonic B decay, $B \to$ charmonium + baryons. Modes of this type were proposed as a potential explanation for the excess in the low momentum region of the inclusive J/ψ momentum spectrum in B decays [3]. The measured branching fraction and the results of a search for the related modes are shown in Table 1.

3. Search for $B^0 \to J/\psi\bar{D}^0$ and $B^+ \to J/\psi\bar{D}^0\pi^+$

A search for this mode is motivated by the proposed intrinsic charm ($q\bar{b}c\bar{c}$) in the B meson as another explanation for the excess in the soft part of inclusive J/ψ momentum spectrum mentioned in the previous section [4]. The results of this search are presented in Table 1.

4. Observation of $B^{+/0} \to \Lambda_c^+\bar{\Lambda}_c^- K^{+/0}$

Recently, Belle observed two-body baryonic B decay $\bar{B}^0 \to \Lambda_c^+\bar{p}$ [10] proceeding via $b \to c\bar{u}d$ transition. In this and next section we present the first observations of exclusive B decays into two charmed baryons in the final state proceeding via $b \to c\bar{c}s$ transition. Figure 1 shows the ΔM and M_{bc} for the B^+-meson decying into $\Lambda_c^+\bar{\Lambda}_c^- K^+$. The measured branching fraction for this decay together with that for the isospin related mode $B^0 \to \Lambda_c^+\bar{\Lambda}_c^- K^0$ are presented in Table 1.

5. Observation of $B^+ \to \bar{\Xi}_c^0\Lambda_c^+$ and Evidence for $B^0 \to \bar{\Xi}_c^-\Lambda_c^+$

The $\Delta E(M_{\rm bc})$ distributions for the $B^+ \to \bar{\Xi}_c^0\Lambda_c^+$ and $B^0 \to \bar{\Xi}_c^-\Lambda_c^+$ decays are shown in Fig. 2 a(b) and Fig. 2 c(d), respectively, where the superimposed curves are the fit results. The measured products of branching fractions are presented in Table 1.

Taking into account the theoretical predictions for $\mathscr{B}(\Xi_c^0 \to \Xi^-\pi^+)$ of $\sim (0.9-2)\%$ [9] and the Belle measurement of $\mathscr{B}(\bar{B}^0 \to \Lambda_c^+\bar{p})$ [10] we obtain $\mathscr{B}(B \to \overline{\Xi}_c^0\Lambda_c^+)/\mathscr{B}(\bar{B}^0 \to \Lambda_c^+\bar{p}) \sim 100$. This disagrees with the naive expectation that the branching fractions for two-body baryonic B decays proceeding via $b \to c\bar{c}s$ and $b \to c\bar{u}d$ transitions should be of the same order [11].

6. Summary

In conclusion, the Belle Collaboration observes for the first time new types of B decays with J/ψ or baryons in the final state: $B^- \to J/\psi\Lambda\bar{p}$, $B^{+/0} \to \Lambda_c^+\bar{\Lambda}_c^- K^{+/0}$ and $B^+ \to \bar{\Xi}_c^0\Lambda_c^+$. Despite small energy release in all of these modes, the measured branching fractions are in the range of $(10^{-5} - 10^{-3})$. Two latter modes are the first examples of exclusive B decays into two charmed baryons. All these new results provide additional information on the mechanism in B decays of baryon formation.

Table 1: Summary of reported results

Decay Branching Fraction	Result	Significance, σ's
$\mathscr{B}(B^- \to J/\psi\Lambda\bar{p})$	$(11.6 \pm 2.8^{+1.8}_{-2.3}) \times 10^{-6}$ [5]	11.1
$\mathscr{B}(B^- \to J/\psi\Sigma^0\bar{p})$	$< 1.1 \times 10^{-5}$ @ 90% CL [5]	-
$\mathscr{B}(B^0 \to J/\psi p\bar{p})$	$< 8.3 \times 10^{-7}$ @ 90% CL [5]	-
$\mathscr{B}(B^0 \to J/\psi\bar{D}^0)$	$< 2.0 \times 10^{-5}$ @ 90% CL [6]	-
$\mathscr{B}(B^+ \to J/\psi\bar{D}^0\pi^+)$	$< 2.5 \times 10^{-5}$ @ 90% CL [6]	-
$\mathscr{B}(B^+ \to \Lambda_c^+\bar{\Lambda}_c^- K^+)$	$(6.5^{+1.0}_{-0.9} \pm 1.1 \pm 3.4) \times 10^{-4}$ [7]	15.4
$\mathscr{B}(B^0 \to \Lambda_c^+\bar{\Lambda}_c^- K^0)$	$(7.9^{+2.9}_{-2.3} \pm 1.2 \pm 4.1) \times 10^{-4}$ [7]	6.6
$\mathscr{B}(B^+ \to \bar{\Xi}_c^0\Lambda_c^+) \times \mathscr{B}(\bar{\Xi}_c^0 \to \bar{\Xi}^+\pi^-)$	$(4.8^{+1.0}_{-0.9} \pm 1.1 \pm 1.2) \times 10^{-5}$ [8]	8.7
$\mathscr{B}(B^0 \to \bar{\Xi}_c^-\Lambda_c^+) \times \mathscr{B}(\bar{\Xi}_c^- \to \bar{\Xi}^+\pi^-\pi^-)$	$(9.3^{+3.7}_{-2.8} \pm 1.9 \pm 2.4) \times 10^{-5}$ [8]	3.8

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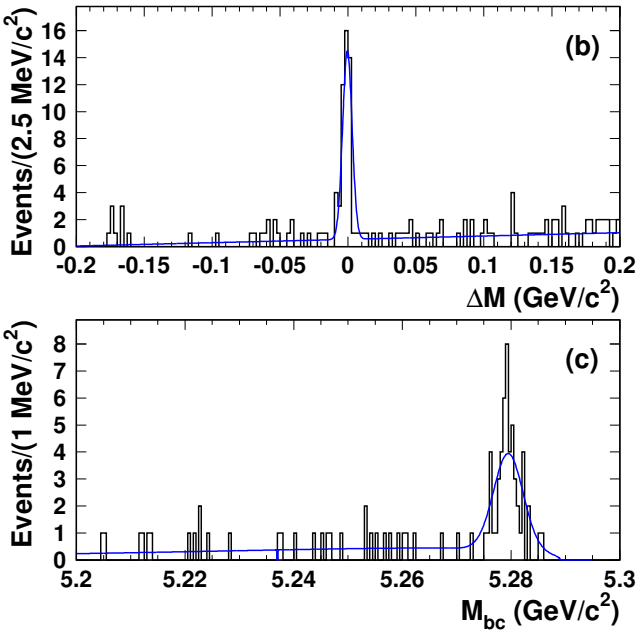

Figure 1: The ΔM(upper) and M_{bc}(lower) distributions for the B^+-meson decying into $\Lambda_c^+ \bar{\Lambda}_c^- K^+$.

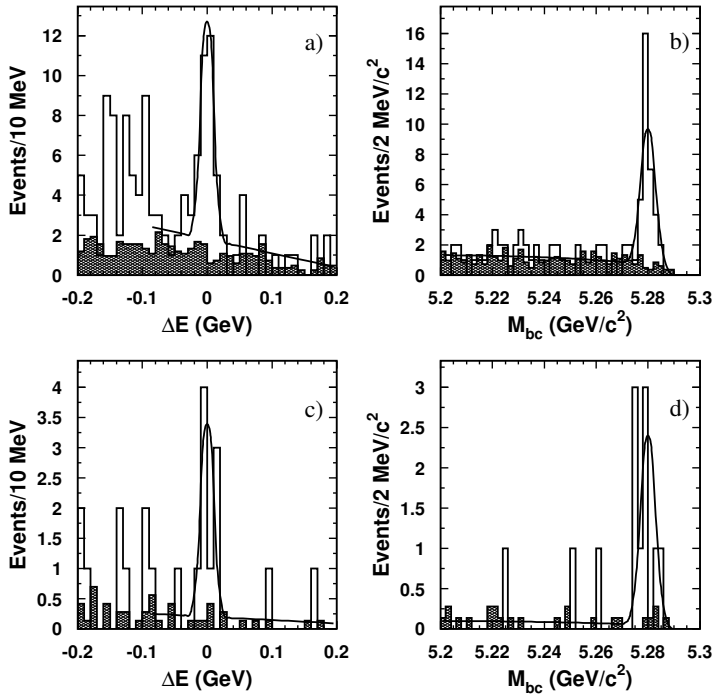

Figure 2: The ΔE and M_{bc} distributions for the $B^+ \to \bar{\Xi}_c^0 \Lambda_c^+$(a, b) and $B^0 \to \bar{\Xi}_c^- \Lambda_c^+$(c, d) candidates.